

**KEY TO THE PUPAL PARASITES OF CALIFORNIA OAKWORM,
PHRYGANIDIA CALIFORNICA (LEPIDOPTERA: DIOPTIDAE),
BASED ON LARVAL EXUVIAE**

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The California oakworm, *Phryganidia californica* Packard, is a common defoliator of coast live oak, *Quercus agrifolia* Neé, particularly in the San Francisco Bay area. The moth is bivoltine with a 9 month spring generation followed by a 3 month fall generation. Cyclic outbreaks occur for 2-3 years followed by relative scarcity for 4-7 years (Horn, 1974). A detailed account of the life history of *P. californica* is given by Harville (1955) who noted regular fluctuations in its population dynamics since 1851 with no apparent harm to trees. However, since *Q. agrifolia* is highly valued as a shade and ornamental tree in public parks and residential areas, highly defoliated trees are considered to sustain aesthetic and monetary losses (Harville, 1955; Wickman, 1971).

The majority of the parasite complex of *P. californica* is associated with the pupal stage (Harville, 1955; Horn, 1974; Young, 1977). However an egg parasite, *Tetrastichus* sp., has been found (Young, 1977) and two tachinid flies, *Actia* sp. and *Zenillia virilis* Aldrich and Webber, were reared from larvae (Harville, 1955; Young, 1977).

Primary pupal parasites include ichneumonids, *Itoplectis behrensii* (Cresson) and *Ephialtes ontario* (Cresson), and a chalcidid, *Brachymeria ovata* (Say). *I. behrensii* was originally described in 1896 with a more complete description given by Townes and Townes (1960) in their revision of the subfamily Pimplinae. This parasite is specific to *P. californica* with no record of an alternate host. *B. ovata* is polyphagous with over 100 recorded hosts (Burks, 1960) and was first recorded on *P. californica* by Burke and Herbert (1920). *E. ontario* was first reported on *P. californica* by Hagen (1949) and is a facultative parasite known mostly to attack lepidopterous pupae found on conifers (Townes and Townes, 1960).

Hyperparasites, in the pupal parasite complex, have been reported to attack only *I. behrensii* (Harville, 1955; Horn, 1974). These include ichneumonids, *Gelis tenellus* (Say), *Mastrus aciculatus* (Provancher) and *Bathyrhix* sp., and a pteromalid, *Dibrachys cavus* (Walker). However, both *D. cavus* and *G. tenellus* were found hyperparasitizing *B. ovata* and *E. ontario* (Young, 1977).

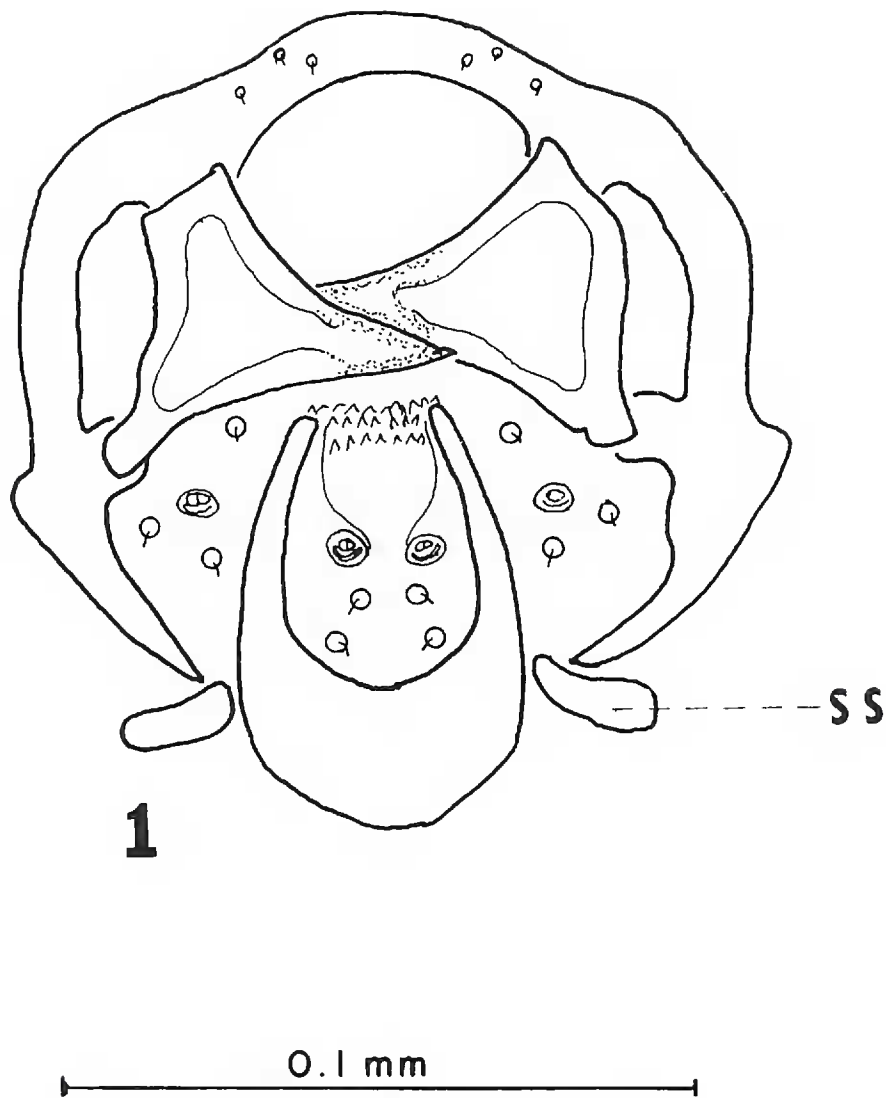


Fig. 1. *Ephialtes ontario*, last stage larva. Buccal armature showing stipital sclerite (SS).

During a previous study it became necessary to identify parasites from post emerged *P. californica* pupae (Young, 1977). The major advantage of this method was that a more accurate assessment of parasite abundance and effectiveness could be made.

Parasite Determinations

Identification of parasite species was based on remnants left in pupae by emerged adults. During fall 1974, several hundred suspected parasitized pupae were collected from oak trees on the campus of the University of California, Berkeley and were individually reared for adult parasites. The adults were identified and *P. californica* pupae from which they emerged were examined. Meconium, cast larval skin, head capsule, emergence hole size and other remnants were used to construct the following key to the pupal parasites of *P. californica*. The hyperparasite *Bathythrix* sp. was excluded from this key because of insufficient recoveries.

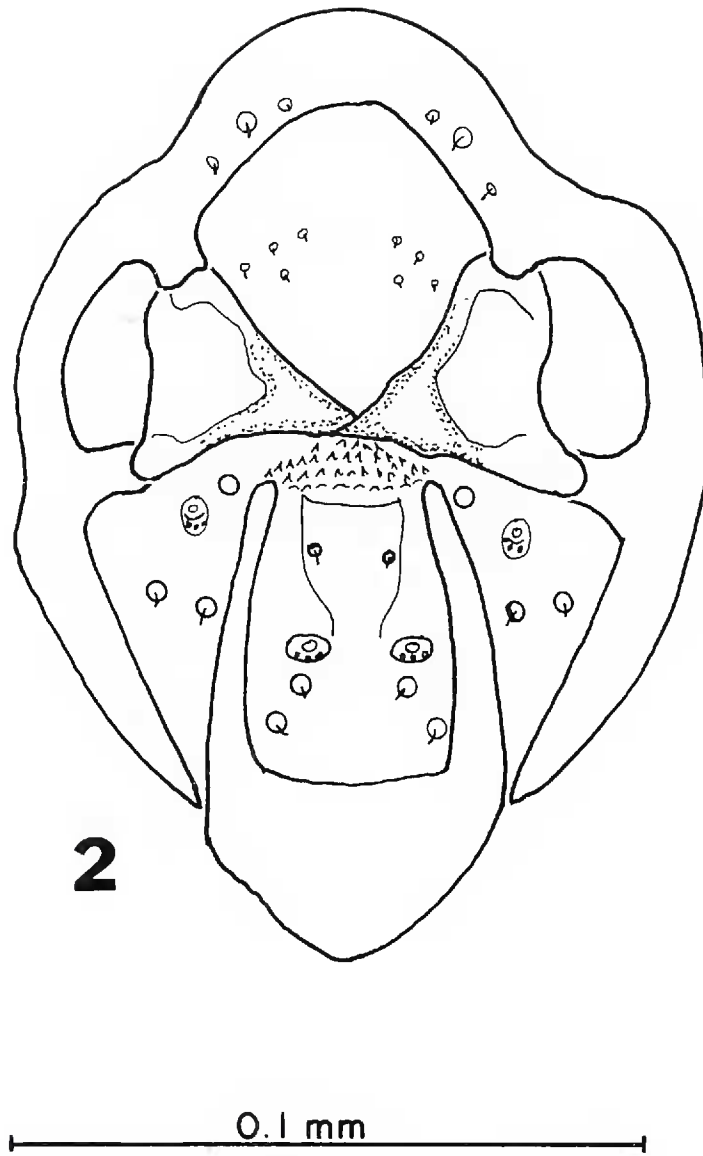


Fig. 2. *Itopectis behrensii*, last stage larva. Buccal armature.

Key to the Pupal Parasites of *Phryganidia californica* Packard

- 1. Pupal wall thick, opaque, ranging from cream color to black; emergence hole(s) present 2
- Pupal wall thin, translucent, split laterally along antennae, terminating to open flap just below head ... Host *Phryganidia californica*
- 2. Meconium present posteriorly or occasionally anteriorly at opposite end of emergence hole Primary Parasite 3
- Meconium absent at either end of pupa; shriveled remains of primary parasite larva present Secondary Parasite 5
- 3. Meconium appears as mass of grayish ovoid pellets, each pellet approximately 0.5 mm long; pupa often showing dark spot between wing pads; cast skin of last larval molt including head capsule of primary parasite present 4
- Meconium packed into smooth mass often filling 1/3 of host pupa;

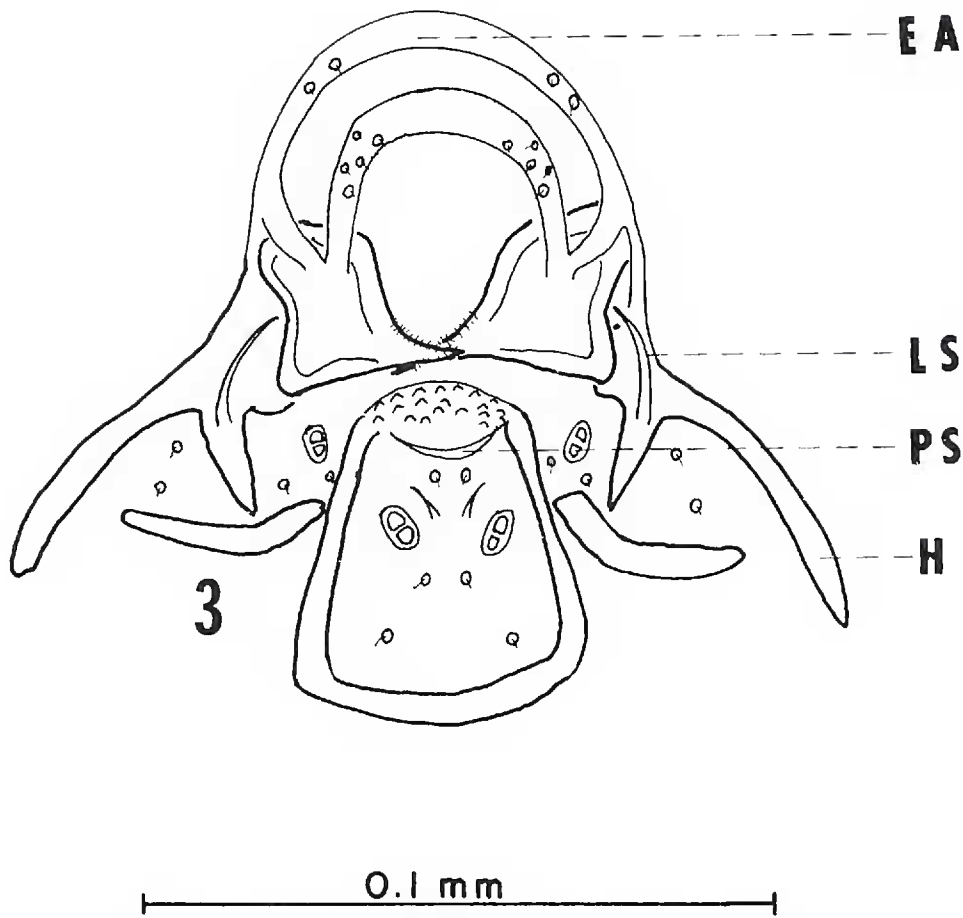


Fig. 3. *Mastrus aciculatus*, last stage larva. Buccal armature showing epistomal arch (EA), lacinial sclerite (LS), prelabial sclerite (PS), hypostoma (H).

- parasite remains consisting of pupal envelope rather than cast skin of last larval molt of primary parasite *Brachymeria ovata*
4. Emergence hole often exceeding 2.2 mm in diameter; buccal armature of head capsule of last larval molt with stipital sclerite present (Fig. 1), not common *Ephialtes ontario*
 Emergence hole seldom exceeding 2.2 mm in diameter; buccal armature of head capsule of last larval molt lacking stipital sclerite (Fig. 2), very common *Itoplectis behrensii*
5. Emergence hole less than 1.0 mm in diameter, pupa containing several parasite pupal envelopes *Dibrachys cavus*
 Emergence hole greater than 1.0 mm in diameter, pupa containing remains of solitary parasite 6
6. Pupa containing flimsy, loosely woven cocoon; head capsule with complete, lightly sclerotized epistomal arch, lacinial sclerites present, hypostomal arm short barely extending beyond stipital sclerite, prelabial sclerite present (Fig. 3) *Mastrus aciculatus*
 Pupa containing thickened cocoon approximately 7.0 mm long and 2.0 mm wide; head capsule with incomplete epistomal arch, la-

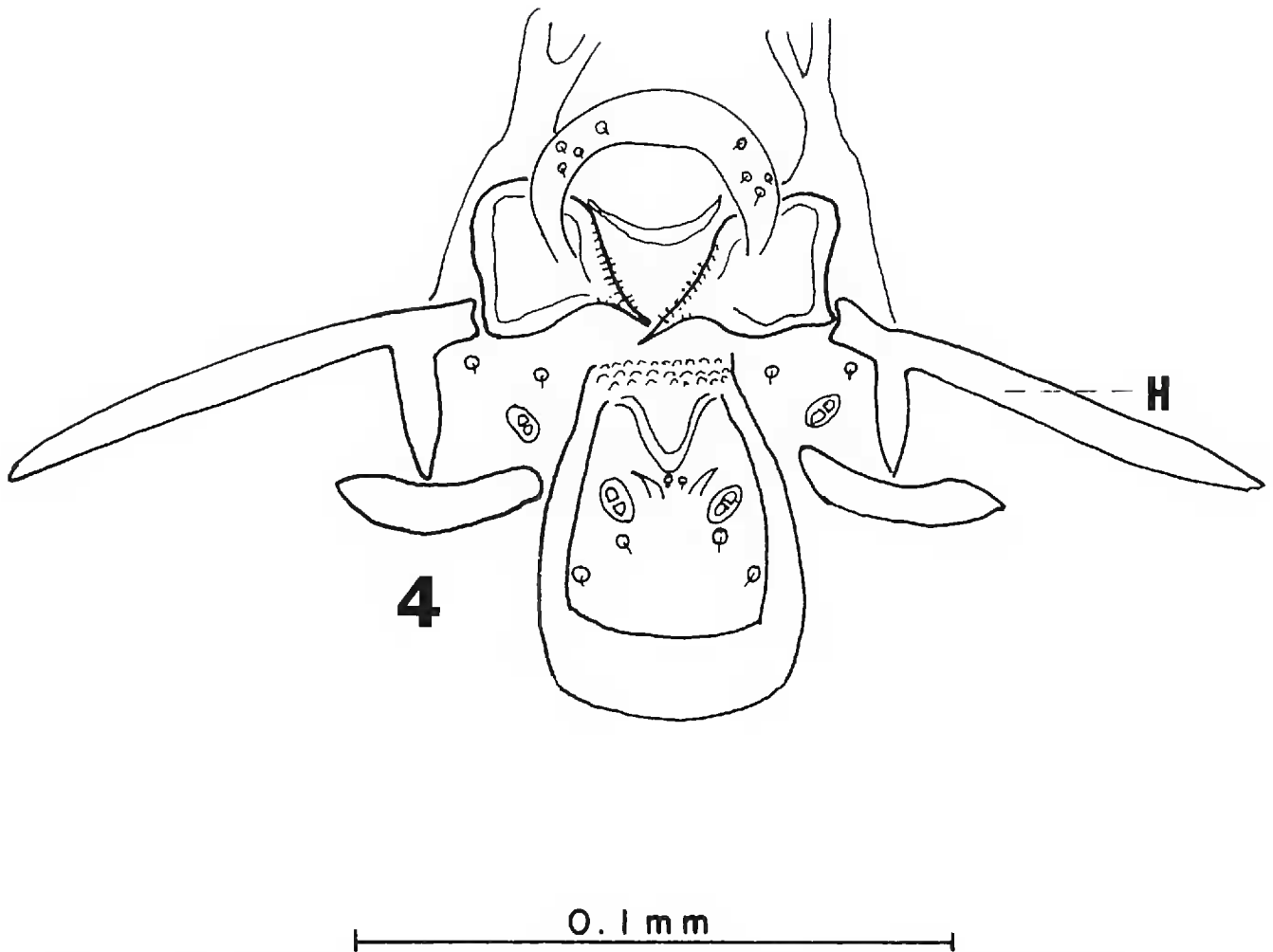


Fig. 4. *Gelis tenellus*, last stage larva. Buccal armature showing hypostoma (H).

cinial sclerite absent, hypostomal arm long extending $\frac{1}{3}$ beyond stipital sclerite, prelabial sclerite absent (Fig. 4) *Gelis tenellus*

Acknowledgments

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